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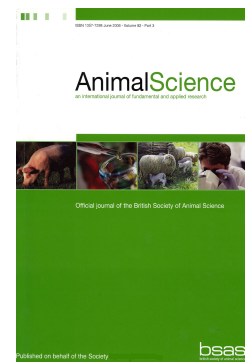
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Factors identifying pigs predisposed to tail biting

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Abstract

Approximately 5% of pigs slaughtered in the UK have been tail-bitten, leading to welfare and production issues. Tail biting is sporadic and not all pigs tail bite. The aim of this study was to identify factors that are common in pigs that perform tail-biting behaviour, and that might be used in a predictive way to identify such animals.

The behaviour of 159 pigs was observed in the post-weaning period. Pigs were weaned at 4 weeks of age. In the week prior to weaning and at 6 weeks of age each pig was individually tested in a tail chew test (tail chew test 1 and 2, respectively). The tail chew test involved recording the pig's behaviour directed towards two ropes, one of which had been soaked in saline solution and the other not. The production performance of the pigs was recorded from birth to 7 weeks of age.

Time spent performing tail-biting behaviour correlated positively with time in contact with the rope in tail chew test 2 ($r = 0.224$, $P < 0.05$), and time spent ear biting correlated positively with time spent in rope directed behaviour in tail chew test 1 ($r = 0.248$, $P < 0.01$). Pigs that spent as much as 1.5% of their time of more performing tail-biting behaviour were lighter at weaning (26 days) and tended to be lighter at 7 weeks of age compared with pigs that spent less than 1.5% of their time performing tail-biting behaviour (weaning weight: $\geq 1.5\%$ tail biting 8.96 kg, $< 1.5\%$ tail biting 9.67 kg, $P < 0.05$; 7-week weight: $\geq 1.5\%$ tail biting 15.75 kg, $< 1.5\%$ tail biting 17.09 kg, $P < 0.08$). There was no significant difference in birth weight between pigs that spent \geq or $< 1.5\%$ of their time performing tail-biting behaviour. Pigs that spent 1.5% of their time or more performing tail-biting behaviour showed significantly lower growth rates between birth and weaning ($\geq 1.5\%$ tail biting 260 g/day, $< 1.5\%$ tail biting 285 g/day, $P < 0.05$) but not between weaning and 7 weeks of age ($\geq 1.5\%$ tail biting 343 g/day, $< 1.5\%$ tail biting 365 g/day, $P > 0.05$).

The results suggest that pigs that tail bite have some nutritional deficiency that results in performance of foraging behaviour that is expressed in intensive housing as ear/tail biting.

Keywords: growth rate, pigs, tail biting.

Introduction

Tail biting is a behavioural vice that leads to poor welfare of the animal being bitten (Signoret, 1983) and to loss of production (Wallgren and Lindahl, 1996). The incidence of tail biting in commercially housed pigs ranges between approximately 2 to 5 percent (Aalund, 1978; Huey, 1996; Guise and Penny, 1998). Tail biting is ubiquitous and has been discussed in scientific literature since the 1960s (England and Spurr, 1967; Van Putten, 1969). However although tail biting is well recognized as a problem it is poorly understood. Many suggestions have been made to explain why pigs tail bite. An encompassing suggestion is that the pig is not in harmony with its environment (Ewbank, 1976;

Simonsen, 1990). A more specific cause was proposed by Fraser (1987a and b) and Fraser *et al.* (1991a) who suggested that tail biting was caused by a nutritional deficiency. For example, it has been suggested that tail biting may be specifically related to a deficiency in salt (Fraser, 1987b). Studies on environmental enrichment have demonstrated that tail biting in conjunction with manipulation of penmates was reduced when bedding or a manipulative substrate was available (Haskell *et al.*, 1996; Fraser *et al.*, 1991b; Beattie *et al.*, 2001). This led to the hypothesis that tail biting may be redirected oral manipulative behaviour (Fraser *et al.*, 1991b). Supporting this, Amory and Pearce (1998) found that tail biting was linked with the type of feeding system, suggesting a link between foraging behaviour and tail biting.

Two facts are known about tail biting : firstly, it is sporadic and secondly not all pigs tail bite. If the cause of tail biting is simply environmental, nutritional or based on a motivation for oral manipulation then the question must be asked why all pigs in a group, or a house, do not perform this behaviour. The aim of this study was to investigate the individual differences between pigs in their performance of tail-biting behaviour and to identify factors that are common in pigs that perform tail-biting behaviour, with the objective of developing a predictive test for predisposition to tail biting.

Material and methods

Design

The behaviour of one hundred and fifty-nine pigs in their home pens was studied from birth to 7 weeks of age. The biological performance of the pigs was recorded and the pigs underwent two tests. At 4 and 6 weeks of age each pig was tested individually in a tail chew test using an artificial tail model. The time spent in, and frequency of, behaviours directed towards the artificial tail were correlated with time spent in, and frequency of harmful social behaviours directed towards penmates in the resident pen.

The aim was to determine if the tail chew test could be used to identify pigs predisposed to tail-biting behaviour.

Animals

Forty-four first cross Large White × Landrace sows were mated with 25 different sires. One hundred and fifty-nine of the progeny were studied as experimental animals and 152 were used as non-experimental animals to maintain group sizes. At weaning (26 days of age) two boars and two gilts each from two litters were mixed together in a group of eight. Four pigs in each group (one boar and one gilt each from two litters) were experimental and four non-experimental.

Housing

Two types of housing were used throughout the duration of the study. The housing was dependent on the age of pig. Pigs changed housing at weaning (26 days of age).

Stage 1 (birth to 26 days of age). In the pre-weaning stage (stage 1) piglets were housed with their dams in a farrowing pen. The farrowing pen measured 2.3 × 1.5 m and had a fully slatted plastic floor. Throughout the 26-day lactation the sow was confined within a farrowing crate. At the front of the pen was an enclosed creep area (0.5 m × 1.5 m), which had a solid floor incorporating a heat mat. Creep food was offered on the floor of the creep area and water was available *ad libitum* from a water nipple.

Stage 2 (5 to 7 weeks of age). At weaning the piglets were mixed (see under *Animals*) and housed in groups of eight in flat-deck pens. Each pen measured 2.5 × 1.2 m and had expanded metal floors and wire mesh partitions. The space allowance per pig was 0.38 m². Food was offered *ad libitum* via a four-space dry hopper and water via water bowls.

Diet

From 10 days pre-weaning to 7 weeks of age (3 weeks post weaning) pigs were offered three commercial diets in sequence. These diets contained (per kg) 220 g crude protein and 16 to 14 g lysine (Milkistart, Milkiwean and Thrift, John Thompson and Sons Ltd).

Behaviour in resident pen

The behaviour of each of the experimental animals in their resident pen was observed between 13:00 and 16:00 h twice per week from weaning to 7 weeks of age. Observations lasted 10 min. Behaviour was recorded directly using a configuration from the Observer program (Nodus) downloaded onto a hand held Psion organiser. The duration and frequency of the behaviours outlined in Table 1 were recorded.

Tail chew tests

Pigs were tested in the 'tail chew test' during the week prior to weaning at 26 days of age (i.e. during day 24 or 25) (tail chew test 1) and at 6 weeks of age (tail chew test 2). The tail chew tests were adaptations of the model used by Fraser (1987b).

Tail chew test 1. In the week prior to weaning the 159 experimental pigs were tested individually in tail chew test 1. The test was carried out in the creep area of the farrowing pen. Two pieces of pliable rope approximately 0.5 m in length were suspended into the creep, reaching approximately 10 cm off the ground. One piece of rope had been soaked for 3 h in a 50 ml/l concentration of sodium chloride and then dried (salty rope). The other piece of rope was not soaked (plain rope). Each piglet was confined in the creep area with the ropes for 10 min. During this time the behaviour of the pig was recorded by video.

Tail chew test 2. Twenty-four hours prior to tail chew test 2 the pigs to be tested were moved from their home pens to individual pens. The pens measured 1.0 × 2.4 m, had insulated solid floors and three of the sides were wire mesh. The back wall of the pen was solid. Food and water were available *ad libitum* via a trough and water nipple respectively. At the onset of the test two pieces of rope 1 m long were suspended from the back partition of the pen reaching approximately 20 cm from the floor. One piece of the rope

Table 1 Ethogram of behaviour in the resident pen

Behaviour	Description
Nose pig	Sniffing, touching body of another pig with snout
Genital/belly	Contact, manipulate belly area, genitals or anal area of another pig
Tail bite	Manipulate, suck or chew tail of penmate
Ear bite	Manipulate, suck or chew ear of penmate

Predictive test for predisposition to tail biting in pigs

Table 2 Ethogram of behaviours observed during tail chew tests 1 and 2

Behaviour	Description
Contact plain rope	Making contact with the plain rope
Chew plain rope	Chewing the plain rope section
Sniff plain rope	Sniffing or nosing the plain rope
Manipulate plain rope	Twisting, nosing or manipulating the plain rope using snout
Contact salty rope	Making contact with the salty rope
Chew salty rope	Chewing the salty rope section
Sniff salty rope	Sniffing or nosing the salty rope
Manipulate salty rope	Twisting, nosing or manipulating the salty rope using snout

had been soaked for 3 h in a sodium chloride solution the other had not; as in tail chew test 1. Behaviour of each pig was recorded during the 10-min test by video.

In each of the tail chew tests, the duration and frequency of behaviours defined in Table 2 were recorded. These included behaviours such as contact rope, chew rope, sniff rope and manipulate rope. A further category of behaviour was created, called rope directed behaviour, which included the total frequency of duration of time spent performing contact, chew, sniff and manipulate behaviours with either the plain or salty rope.

Production measures

Pigs were weighed at birth, at weaning (26 days), and at 7 weeks of age. Daily live-weight gain (DLWG) was calculated for the period between birth and weaning, and between weaning and 7 weeks of age.

Statistical analysis

The data were analysed using Genstat, version 5 (Lawes Agricultural Trust, 1989). The duration of individual behaviours was expressed as the percentage of total time observed and the frequencies of the behaviours were expressed as frequency per min. Pearson's product moment correlations (Howell, 1982) were calculated for behaviours within the resident pen and tail chew tests, and for resident pen behaviours with tail chew tests 1 and 2 and live-weight gain. Analysis of variance was used to identify if there was any significant difference in birth weight, weaning weight or 7-week weight between pigs who spent $\geq 1.5\%$ compared with those pigs who spent $< 1.5\%$ of their time performing harmful social behaviour in resident pen. The level of 1.5% was chosen retrospectively, based on observations of distributions of tail-biting behaviour, to differentiate the more extreme tail biting individuals in the population.

Results

Behaviour in resident pen

The frequency of tail biting correlated positively with the frequency of 'nose pig' behaviour ($r = 0.308$, $P < 0.01$), ear biting ($r = 0.191$, $P < 0.01$) and nosing in the genital/belly region ($r = 0.206$, $P < 0.01$).

Distribution of behaviour in resident pen

The percentage of pigs that spent 1% or less of their time in the behaviours, ear biting, nosing genital/belly region and tail biting was 67%, 99% and 78% respectively. For all three behaviours the distribution of pigs was strongly skewed to the left, however, ear and tail biting showed a slower rate of

decline in the distribution. Thirty-three percent of pigs spent greater than or equal to 1.5% of their time ear biting, 22% of pigs spent greater than or equal to 1.5% of their time tail biting and 1% of pigs spent greater than or equal to 1.5% of their time nosing the genital/belly region (see Figures 1, 2 and 3).

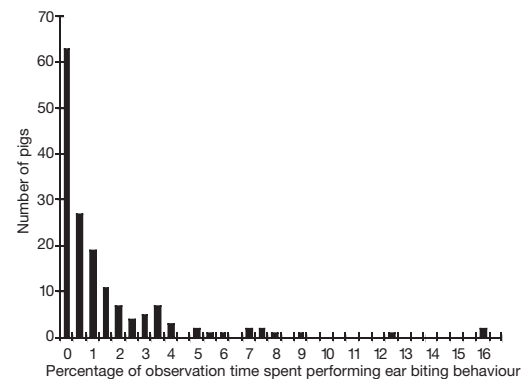


Figure 1 Frequency distribution of ear biting behaviour.

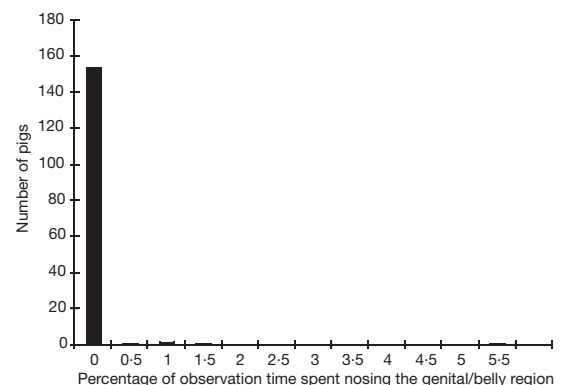


Figure 2 Frequency distribution of genital/belly nosing behaviour.

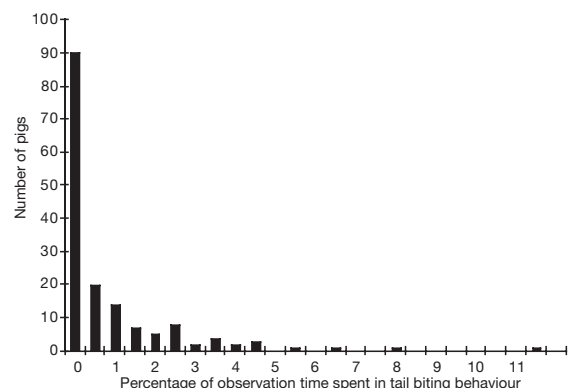


Figure 3 Frequency distribution of tail biting behaviour.

The percentage of pigs that performed ear biting, nosing genital/belly region or tail biting less than or equal to 0.1 times per min was 59%, 99% and 74% respectively.

Nosing pig behaviour showed a more normal frequency distribution than the other behaviours recorded in the resident pen (Figure 4).

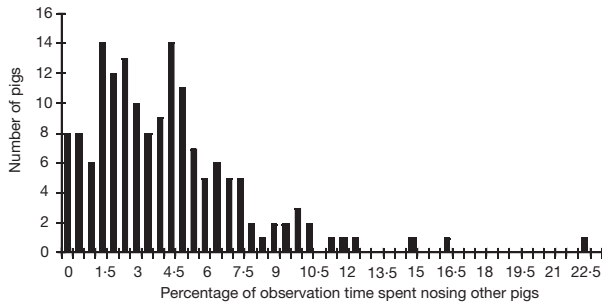


Figure 4 Frequency distribution of nosing pig behaviour.

Behaviour in resident pen and tail chew tests

Tail chew test 1. The time spent in the behaviour 'nosing pig' in the resident pen during stage 2 correlated positively with the time spent in rope directed behaviour ($r = 0.201$, $P < 0.05$), sniffing the salty rope ($r = 0.209$, $P < 0.05$) and chewing the salty rope ($r = 0.256$, $P < 0.01$) in 'tail chew test 1' at 24/25 days of age. Time spent ear biting during stage 2 correlated with time spent in rope-directed behaviour ($r = 0.248$, $P < 0.01$), manipulating plain rope ($r = 0.223$, $P < 0.05$), sniffing salty rope ($r = 0.245$, $P < 0.01$) and chewing salty rope ($r = 0.393$, $P < 0.01$) in 'tail chew test 1'.

Tail chew test 2. Time spent in the behaviour 'nosing pig' by pigs in the resident pen during stage 2 correlated positively with time spent contacting the plain rope ($r = 0.196$, $P < 0.05$) in 'tail chew test 2' at 6 weeks of age. Time spent tail biting during stage 2, correlated positively with time in contact with the plain rope ($r = 0.224$, $P < 0.05$).

Consistency across tail chew tests 1 and 2. Behaviours directed towards the tail models showed significant correlations both within and between tests. The frequency of sniffing the salty rope in 'tail chew test 1' correlated positively with the frequency at which the salty rope was manipulated in 'tail chew test 2' ($r = 0.174$, $P < 0.05$). Time spent chewing the plain rope by pigs in 'tail chew test 1' correlated positively with time spent in 'tail chew test 2' manipulating the salty rope ($r = 0.174$, $P < 0.05$), chewing the plain rope ($r = 0.610$,

$P < 0.001$), chewing the salty rope ($r = 0.195$, $P < 0.05$) and in rope directed behaviour ($r = 0.407$, $P < 0.001$). In addition the frequency of chewing the plain rope by pigs in 'tail chew test 1' correlated with the frequency of chewing the plain and salty ropes in 'tail chew test 2' (chew plain, $r = 0.261$, $P < 0.001$; chew salty, $r = 0.221$, $P < 0.01$). Duration of rope directed behaviour in 'tail chew test 1' correlated with duration of chewing the plain rope ($r = 0.302$, $P < 0.01$) and rope directed behaviour ($r = 0.201$, $P < 0.05$) in 'tail chew test 2'. The frequency of behaviour directed towards the rope by pigs in 'tail chew test 1' correlated with the frequency at which the salty rope was manipulated ($r = 0.201$, $P < 0.05$) and frequency of rope directed behaviour ($r = 0.174$, $P < 0.05$) in 'tail chew test 2'.

Production performance (Table 3)

Pigs that spent greater than or equal to 1.5% of their time in tail-biting behaviour (animals in the upper quartile for this behaviour) were lighter at weaning (26 days) ($P < 0.05$) and tended to be lighter at 7 weeks of age ($P < 0.08$) compared with those pigs that spent less than 1.5% of their time performing tail-biting behaviour. There was no significant difference in birth weight between pigs that spent \geq or $<$ 1.5% of their time performing tail-biting behaviour.

Pigs that spent greater than or equal to 1.5% of their time in tail-biting behaviour showed a lower DLWG during stage 1 compared with those pigs which spent less than 1.5% of their time performing tail-biting behaviour ($P < 0.05$). There was no significant effect of tail-biting behaviour on DLWG during stage 2 ($P > 0.05$).

Discussion

The correlation data show that tail biting is linked with ear biting and nosing in the genital/belly region. Van Putten (1969) suggested that pigs have a motivation to bite ears and tails but that this biting is mainly concentrated on the tail as ear chewing is more likely to provoke an attack by the recipient. The relationship between tail and ear biting is supported by the finding that tail docked pigs had a lower incidence of injured tails than pigs with intact tails. However, tail docked pigs had a higher incidence of ear damage (Hunter *et al.*, 1999).

Evidence suggests that outbreaks of tail biting occur in two stages (Blackshaw, 1981). The actual tail biting observed is the result of many of the pigs in the pen biting an injured tail,

Table 3 Relationship between percentage of time spent performing tail-biting behaviour in the resident pen and body weight and growth rate parameters

	Percentage of time spent performing tail-biting behaviour		s.e.	Significance
	< 1.5	≥ 1.5		
Body weight (kg)				
Birth	1.81	1.87	0.050	
Weaning (26 days)	9.67	8.96	0.206	*
7 weeks	17.09	15.75	0.481	†
Growth rate (g/day)				
Stage 1 (birth to weaning)	285	260	7.4	*
Stage 2 (weaning to 7 weeks)	365	343	21.1	

† Approaching significance ($P < 0.1$).

Predictive test for predisposition to tail biting in pigs

that is a tail which has an open wound and available blood. However, this has been preceded by persistent low-intensity chewing by one or a few pigs in the pen (Van Putten, 1969; Blackshaw, 1981; Sambras, 1985). The current study investigated the pigs that created the initial wound, that is, the pigs involved in persistent chewing of penmates. These animals were in the minority within pens. For example, only 22% of pigs were observed performing persistent ($\geq 1.5\%$ of time) tail biting between 4 and 7 weeks of age. This may explain the sporadic nature of outbreaks of tail biting.

Pigs that spent more time biting the ears and tails of their penmates also spent longer chewing the ropes in the tail chew tests. This may suggest that the same underlying predisposition was being measured in both situations. However, the correlation coefficients between behaviour directed towards the ropes in the tail chew test and harmful social behaviour in the resident pen were weak. Further evaluation of the tail chew test as a possible predictor of predisposition to show harmful social behaviour is required over a wide range of environmental conditions. 'Rope directed behaviour' in the tail chew tests was consistent over time; pigs which performed high levels of rope directed behaviours pre-weaning continued to show high levels of rope directed behaviour post weaning. Work by Beattie *et al.* (1995; 1996) has shown that behaviours developed early in the life of the pig remain until adulthood. Hence the pigs identified as ear and tail biters in the post-weaning stage and chewers of rope in this study are likely to retain these behaviours throughout the growing and finishing stages, where more severe tail biting outbreaks are observed.

One parameter that appeared to discriminate between pigs that performed ear and tail-biting behaviour, and that showed a high level of chewing behaviour in the tail chew test, and those that did not, was growth rate during stage 1. Pigs that were biters and chewers showed lower growth rates during this stage, and consequently were significantly lighter at weaning and also tended to be lighter at 7 weeks of age.

A depression in growth rate has been recorded among pigs when tail biting occurs (England and Spurr, 1967; Wallgren and Lindahl, 1996). However, this depression is due to the reduced growth rates of the pigs that have been tail bitten not the pigs that are the proponents of the behaviour. Work by Fraser *et al.* (1991a) found that pigs with lower growth rates were attracted to blood in a tail chew test. Fraser *et al.* (1991a) proposed that this may explain why a variety of factors such as diet (Sambras, 1985; Smith and Penny, 1986) and environmental factors (Olsson and Hederstrom, 1989; Peterson *et al.*, 1995), which can depress growth, are associated with tail biting.

The pigs in this study were all housed in the same environmental conditions and offered the same diets. The difference in growth rate in these pigs was primarily in the pre-weaning stage. Pigs that performed ear and tail biting were not significantly lighter at birth compared to pigs which did not ear/tail bite.

Two possibilities exist. Pigs that have poorer growth rates during the lactation period are nutritionally deprived and

thus perform increased levels of foraging behaviour (e.g. chewing), which persists into the post-weaning period, and/or the pigs with lower growth rates in the lactation period are chronically stressed in some way and this leads to heightened attraction for specific nutrients.

Kyriazakis (1994) suggested that pigs make foraging decisions based on metabolic deficiencies in their internal state. These metabolic deficiencies could occur because the animal cannot access the required amount of food, due to social competition (O'Connell and Beattie, 1999), or because the animal is using specific nutrients at a higher rate than its penmates. Animals that are stressed have higher levels of adrenocorticotrophin hormone (ACTH) in their blood, which leads to an increase in sodium appetite (Denton, 1982). In addition, many of the hormones and brain neurotransmitters associated with regulation of behaviour and stress responses of animals are synthesized from amino acids (Mench and Shea, 1988; Harper and Peters, 1989; Burrows *et al.* 1997), hence stressed animals may be deficient in specific amino acids because of increased usage.

Conclusions

Tail-biting behaviour appears to be linked to other harmful social behaviours such as ear biting and nosing in the genital/belly region. This study showed that pigs with lower growth rates during the lactation period subsequently spent more time performing ear/tail-biting behaviour and chew more when offered a rope in a tail chew test. It is suggested that pigs that tail bite have (or have previously suffered) some nutritional deficiency that results in performance of foraging behaviour, expressed as persistent chewing. The possible use of the tail chew test to predict tail biting predisposition requires further evaluation in a wider range of environmental conditions.

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